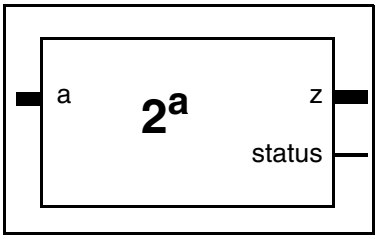
DW_fp_exp2

Floating-Point Base-2 Exponential (2^a)

Version, STAR, and myDesignWare Subscriptions: IP Directory

Features and Benefits

Revision History



- The precision is controlled by parameters, and covers formats in the IEEE Standard 754
- Exponents can range from 3 to 31 bits
- Fractional part of the floating-point number can range from 2 to 58 bits
- A parameter controls the use of denormal values.

Description

The DW_fp_exp2 component computes the Base-2 exponential of a floating-point input a, delivering an output $z=2^a$ that is also a floating-point value.

The parameter ieee_compliance controls the use of denormals and NaNs, as done for other FP operators in this library. When *ieee_compliance* = 0, the operator takes NaN values as infinities, and denormals as zeros. When *ieee_compliance* = 1, the component accepts and generates denormalized values, handles NaN inputs, and delivers NaN outputs when appropriate. Independently of the value of this parameter, the floating-point format can be adjusted to match one of the formats defined in the IEEE Standard 754.

The output status is an 8-bit value that carries the status flags for the FP operation, as described in *Datapath Floating-Point Overview*.

Table 1-1 Pin Description

Pin Name	Width	Direction	Function
a	(*sig_width* + *exp_width* + 1) bits	Input	Input data
z	(*sig_width* + *exp_width* + 1) bits	Output	Base-2 exponential = 2^a
status	8 bits	Output	Status flags for the result For details, see STATUS Flags in the *Datapath Floating-Point Overview*.

Table 1-2 Parameter Description

Parameter	Values	Description
sig_width	2 to 58[a]	Word length of fraction field of floating-point numbers a and z.
exp_width	3 to 31	Word length of biased exponent of floating-point numbers a and z.

Table 1-2 Parameter Description (Continued)

Parameter	Values	Description
ieee_compliance	0 or 1	When 1, the generated architecture is capable of dealing with denormals and NaNs.
arch	0 to 2 Default: 2	Implementation selection: ■ 0 = Area optimized ■ 1 = Speed optimized ■ 2 = Obsolete implementation retained for backward compatibility; will be removed in a subsequent release

a. The synthesis model fully supports this range, as does the Verilog simulation model in VCS, but the VHDL simulation model (in all simulators) and the Verilog simulation model in non-VCS simulators are limited to a range of 2 - 36.

Table 1-3 Synthesis Implementations

Implementation Name	Function	License Feature Required
rtl	Implement using the Datapath Generator technology combined with static DesignWare components	DesignWare

Table 1-4 Simulation Model

Model	Function
DW02.DW_FP_EXP2_CFG_SIM	Design unit name for VHDL simulation
dw/dw02/src/DW_fp_exp2_sim.vhd	VHDL simulation model source code
dw/sim_ver/DW_fp_exp2.v	Verilog simulation model source code

Given the properties of algorithms to compute the exponential function, and the goal to have a component with good QoR, this component does not have rounding mode control as other FP components in the library. The error is bounded to have a maximum of 2 ulps.

The *arch* parameter controls implementation alternatives for this component. Different values result in different numerical behavior, but the error on the computed values is always bounded by a maximum of 2 ulps. You should experiment with this parameter to find out which value provides the best QoR for your design constraints and technology. Using *arch* = 0 (area optimized implementation) usually provides the best QoR for most time constraints.

Alternative Implementation of Floating-point Base-2 Exponential with DW_lp_fp_multifunc

The floating-point base-2 exponential operation can also be implemented by DW_lp_fp_multifunc component, which evaluates the value of floating-point base-2 exponential with a maximum of 2 ulps error bound. There will be 1 ulp difference between the value from DW_lp_fp_multifunc and the value from DW_fp_exp2. Performance and area of the synthesis results are different between the DW_fp_exp2 and base-2 exponential implementation of the DW_lp_fp_multifunc, depending on synthesis constraints, library cells and synthesis environments. By comparing performance and area between the base-2 exponential implementation of DW_lp_fp_multifunc and DW_fp_exp2 component, the DW_lp_fp_multifunc provides more choices for the better synthesis results.

Below is an example of the Verilog description for the floating-point base-2 exponential of the DW_lp_fp_multifunc. For more detailed information, see the DW_lp_fp_multifunc datasheet.

```
DW_lp_fp_multifunc #(sig_width, exp_width, ieee_compliance, 64) U1 (
    .a(a),
    .func(16'h0040),
    .rnd(3'h0),
    .z(z),
    .status(status)
);
```

For more information on the floating-point system defined for all the floating-point components in the DesignWare Library, including `status` bits and floating-point formats, refer to the *Datapath Floating-Point Overview*.

Related Topics

- Datapath Floating-Point Overview
- DesignWare Building Block IP User Guide

HDL Usage Through Component Instantiation - VHDL

```
library IEEE,DWARE;
use IEEE.std_logic_1164.all;
use DWARE.DW_Foundation_comp_arith.all;

entity DW_fp_exp2_inst is
     generic (
        inst_sig_width : POSITIVE := 10;
        inst_exp_width : POSITIVE := 5;
        inst_ieee_compliance : INTEGER := 0;
        inst_arch : INTEGER := 2
        );
     port (
        inst_a : in std_logic_vector(inst_sig_width+inst_exp_width downto 0);
       z_inst : out std_logic_vector(inst_sig_width+inst_exp_width downto 0);
        status_inst : out std_logic_vector(7 downto 0)
        );
   end DW_fp_exp2_inst;

architecture inst of DW_fp_exp2_inst is

begin

    -- Instance of DW_fp_exp2
    U1 : DW_fp_exp2
        generic map (
                sig_width => inst_sig_width,
                exp_width => inst_exp_width,
                ieee_compliance => inst_ieee_compliance,
                arch => inst_arch
                )
        port map (
                a => inst_a,
                z => z_inst,
                status => status_inst
                );

end inst;

-- pragma translate_off
configuration DW_fp_exp2_inst_cfg_inst of DW_fp_exp2_inst is
 for inst
 end for; -- inst
end DW_fp_exp2_inst_cfg_inst;
-- pragma translate_on
```

HDL Usage Through Component Instantiation - Verilog

```
module DW_fp_exp2_inst( inst_a, z_inst, status_inst );

parameter inst_sig_width = 10;
parameter inst_exp_width = 5;
parameter inst_ieee_compliance = 0;
parameter inst_arch = 2;


input [inst_sig_width+inst_exp_width : 0] inst_a;
output [inst_sig_width+inst_exp_width : 0] z_inst;
output [7 : 0] status_inst;

    // Instance of DW_fp_exp2
    DW_fp_exp2 #(inst_sig_width, inst_exp_width, inst_ieee_compliance, inst_arch) U1 (
                        .a(inst_a),
                        .z(z_inst),
                        .status(status_inst) );

endmodule
```

Revision History

For notes about this release, see the *DesignWare Building Block IP Release Notes*.

For lists of both known and fixed issues for this component, refer to the STAR report.

For a version of this datasheet with visible change bars, click here.

Date	Release	Updates
October 2022	DWBB_202203.5	■ Clarified error bounding in ulps on page 2 and page 3
January 2020	DWBB_201912.1	■ Corrected port names for DW_lp_fp_multifunc in "Alternative Implementation of Floating-point Base-2 Exponential with DW_lp_fp_multifunc" on page 3
July 2019	DWBB_201903.3	■ Removed reference to minPower library in "Alternative Implementation of Floating-point Base-2 Exponential with DW_lp_fp_multifunc" on page 3
March 2019	DWBB_201903.0	■ Clarified value '2' of the arch parameter in Table 1-2 on page 1; this value will be obsoleted in a subsequent release
July 2018	DWBB_201806.1	■ For STAR 9001366624, in Table 1-2 on page 1, clarified the range of *sig_width* for the VHDL simulation model (in all simulators) and the Verilog simulation model for non-VCS simulators ■ Added this Revision History table and the document links on this page

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